

Republic of Kenya

EDICT OF GOVERNMENT

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KS 2383-2 (2011) (English): The warehousing of dangerous goods, Part 2: The storage and handling of gas cylinders (Draft Standard)



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KENYA STANDARD

DKS 2383 - 2 :2011

**The warehousing of dangerous goods
Part 2: The storage and handling of gas
cylinders**

TECHNICAL COMMITTEE REPRESENTATION

The following organizations were represented on the Technical Committee::

Ministry of roads and public works – materials department

Government chemist

Consumer information network

Agrochemical Association of Kenya

Kel Chemicals Ltd.

Kirdi

Nema

Kenya Railways

Ministry of labour, occupational health and safety services

Pest control product board

Kenya Maritime Authority

Kenya Airways

Kenya Transport Association

African Airline Association

Kenya ports authority

Radiation protection board

Energy Regulatory commission

National oil cooperation

Kenya Bureau of Standards — Secretariat

REVISION OF KENYA STANDARDS

In order to keep abreast of progress in industry, Kenya Standards shall be regularly reviewed. Suggestions for improvements to published standards, addressed to the Managing Director, Kenya Bureau of Standards, are welcome

KENYA STANDARD

The warehousing of dangerous goods Part 2: The storage and handling of gas cylinders

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Foreword

This Kenya Standard was developed by the Technical Committee on Transportation of dangerous goods under the supervision of the standards project committee, and is in accordance with the procedures of the Bureau In **3.2** mention is made of authority that has jurisdiction over the storage of gases
Energy regulatory commission
Annex A is for information only. Annexes B and C form an integral part of this document.
Acknowledgement is hereby made for the assistance derived from these sources

SANS 10263-2:2008

Public Review Draft

The warehousing of dangerous goods

Part 2:

The storage and handling of gas cylinders

1 Scope

This part of Kenyan standard specifies requirements for the safe handling and storage of industrial and medical gas cylinders for compressed, liquefied or dissolved gases that have a water capacity of 0,5 L to 150 L throughout the supply chain, to and from end users. It also includes undercover and open air conditions. Sites where gas cylinders are filled are specifically excluded.

This standard excludes liquefied petroleum gas (LPG),

2 Normative references

The following referenced documents are indispensable for the application of this part of SANS 10263. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from Standards South Africa.

ISO 7225, *Gas cylinders – Precautionary labels*.

SANS 1186-1, *Symbolic safety signs – Part 1: Standard signs and general requirements*.

SANS 10006, *Colour marking and identification of medical gas cylinders and anaesthetic apparatus*.

SANS 10019 (SABS 019), *Transportable metal containers for compressed gas – Basic design, manufacture, use and maintenance*.

SANS 10142-1, *The wiring of premises – Part 1: Low-voltage installations*.

SANS 10228, *The identification and classification of dangerous goods for transport*.

SANS 10263-0, *The warehousing of dangerous goods – General requirements*.

SANS 10400 (SABS 0400), *The application of the National Building Regulations*.

3 Definitions

For the purposes of this part of standard, the definitions given in KS 2324-1-8:2010 and the following apply.

3.1

access

means, for example, walkways, platforms, stairways, ladders and roads, by which a person or a vehicle enters and exits a particular location

3.2

approved

acceptable to the authority having jurisdiction over the storage of gases (see foreword)

3.3

asphyxiant

gas or vapour without toxic properties which, when in sufficient quantity, excludes oxygen from the blood and can result in unconsciousness

NOTE Death may be almost immediate if all oxygen from the air is excluded.

3.4

combustible materials

materials of a type and quantity sufficient to produce a heat radiation hazard in the event of them catching fire

NOTE Combustible materials include vegetation.

3.5

compressed gas

gas which, when packaged under pressure, is entirely gaseous at $-50\text{ }^{\circ}\text{C}$; including all gases with a

critical temperature of $-50\text{ }^{\circ}\text{C}$ or less

3.6

corrosive gas

gas or a mixture of gases which, by chemical reaction, will materially damage or even destroy metals

3.7

dissolved gas

gas which, when packaged under pressure, is dissolved in a liquid phase solvent

3.8

gas

state of matter that is characterized by very low density and viscosity (relative to liquids and solids), comparatively great expansion and contraction with changes in pressure and temperature, the ability to diffuse into other gases, and the ability to occupy with almost complete uniformity the whole of any container

3.9

gas manufacturer

person or business concerned that produces gas or fills cylinders (or both)

3.10

handling

moving, connecting or disconnecting a gas cylinder under normal conditions of storage

3.11

hard standing

a hard, well drained, level and prepared stable surface for cylinder storage.

NOTE Examples of acceptable materials are concrete, interlocking blocks, bricks or a steel plate, excluding combustible material.

3.12

hazardous area

area in which an explosive, asphyxiant, toxic, corrosive or flammable atmosphere may be present in quantities that require special precautions such as confinement or dispersion

3.13

ignition source

naked flame, incandescent material, and electrical or mechanical equipment that can ignite an atmosphere resulting in explosion or fire

3.14

incompatible

substances that have the ability to react or combine and

- a) increase the hazard of an individual gas,
- b) cause deterioration or damage to the cylinder(s), or
- c) increase the likelihood of contamination by a toxic gas

NOTE Substance (gas) that is "dangerous when wet" is an example of an incompatible gas.

3.15

liquefied gas

gas which, when packaged under pressure, is partially liquid at temperatures above $-50\text{ }^{\circ}\text{C}$

NOTE A distinction is made between

- a) a high pressure liquefied gas with a critical temperature between $-50\text{ }^{\circ}\text{C}$ and $+65\text{ }^{\circ}\text{C}$, and
- b) a low pressure liquefied gas with a critical temperature above $+65\text{ }^{\circ}\text{C}$.

3.16

misuse

tampering, defacing or utilizing a gas cylinder for a purpose other than that for which it was manufactured

3.17

permanent gas

gas that, at a temperature of $50\text{ }^{\circ}\text{C}$, has a vapour pressure exceeding 300 kPa or is completely gaseous at a temperature of $20\text{ }^{\circ}\text{C}$ and at a pressure of 101,3 kPa

3.18

safety data sheet

document issued by a manufacturer of dangerous goods, that lists information about the handling,

storage, transport and emergency procedures relevant to the dangerous goods supplied by the manufacturer

3.19

storage facilities

3.19.1

detached

storage in either an open outside area or a separate building containing no incompatible materials and located away from other structures

3.19.2

segregated

positioning of gaseous substances of Class 2 in terms of KS 2324-1-8:2010 in separate areas within a store or warehouse

NOTE The concepts "segregation" and "separation" are subject to widespread misinterpretation in industry; considerable differences in usage exists, and there is no universally accepted set of definitions of these terms. The onus is nevertheless on the person(s) responsible for a store, and on a warehouse controller, to ensure that gas cylinders are stored in a safe and responsible manner at all times.

3.19.3

separated

physical separation of different groups of substances of Class 2 in terms, either into separate stores or warehouses or by means of separating elements such as a wall that has a specific fire resistance and that is used between divisions, occupancies or tenancies in a building

3.20

supply chain

movement of cylinders from the place where they were last filled to the point of use and the return to the owners filling site

3.21

toxic gas

substance that is toxic by inhalation and is a gas at 20 °C or less and at a pressure of 101,3 kPa

3.22

wall or barrier

protection provided by a structure or material having a fire resistance rating of at least 30 min

3.23

warehouse

facility where gas cylinders are received, stored and dispatched

4 General

4.1 Application of this standard

There is no objection to the use of other national or international standards, or systems, methods, or means that meet or exceed the requirements of this standard. Technical documentation shall be submitted to the authority having jurisdiction (see 3.2) that demonstrates compliance with this standard through rational design and provided that the system, method, or means is approved for the intended purpose.

4.2 Classification

4.2.1 Dangerous gases shall be classified in accordance with KS 2324-1-8:2010 into three divisions as follows:

- a) Division 2.1 – flammable gases;
- b) Division 2.2 – non-flammable non-toxic gases; and
- c) Division 2.3 – toxic gases.

4.2.2 Gases to be found in gas cylinders include the following:

- a) permanent gas; (see 3.17);
- b) compressed gas (see 3.5);
- c) liquefied gas (see 3.15); and
- d) dissolved gas (see 3.7).

4.3 Safety requirements

4.3.1 Warning notes about gases

4.3.1.1 Although some gases are chemically inert, these gases, and others accepted as non-toxic

under normal circumstances, can be asphyxiating in high concentrations.

4.3.1.2 Many gases have a marked narcotic effect at comparatively low concentrations, or can emit highly toxic vapours or fumes if involved in a fire.

4.3.1.3 All gases that are heavier than air present a potential danger if allowed to accumulate.

4.3.2 Hazard precedence for gases

Gases and gas mixtures that present hazards associated with more than one division of Class 2 shall be classified according to. KS 2324-1-8:2010

5 Warning information and responsibilities

5.1 Warning notices, symbolic safety signs and product labels

5.1.1 General

5.1.1.1 All symbolic safety signs and warnings shall be relevant and appropriate and shall be positioned so that they are

- a) clearly visible at all times,
- b) not subject to misinterpretation, and
- c) not subject to damage during normal storage operations.

5.1.1.2 All gases in cylinders shall be considered hazardous on account of their properties and pressure. Cylinders shall not be considered to be empty because of residual products.

5.1.1.3 All workers in the cylinder storage areas shall be trained in the meaning of the signs, warning notices, symbols on the cylinder labels and the interpretation of the written instructions.

5.1.2 Warning notices

5.1.2.1 Outside the warehouse

At the entrance to the warehouse the warning "Storage of dangerous substances – Unauthorized entry prohibited" shall be displayed in red letters on a white background. The warning notice shall include emergency telephone contact details, and shall be in English and in at least one other language indigenous to the region. The height of the letters shall not be less than 75 mm.

5.1.2.2 Inside the warehouse

Every type of storage area shall be clearly demarcated, for example separate storage areas for flammable, oxidizing, inert and toxic gases, shall display the relevant class diamonds of dimensions 250 mm x 250 mm. A list of emergency telephone contact details shall be clearly displayed.

5.1.3 Symbolic safety signs

Symbolic safety signs shall be displayed outside and inside the warehouse to indicate the appropriate safety-related features such as

- a) no smoking, and
- b) no naked flames.

The dimensions of the symbolic safety signs shall be at least 290 mm x 290 mm.

5.1.4 Product labels

The storage, acquisition, sale and use of gases in cylinders that are not clearly and indelibly labelled shall be forbidden. Labels shall comply with the requirements of ISO 7225.

5.2 The responsibilities of the store manager or the warehouse controller

5.2.1 General

The responsibilities of the store manager or the warehouse controller shall be stipulated in writing and shall include the following:

- a) all safety, operating and emergency procedures;
- b) provision of first aid facilities and suitably trained staff;
- c) stock records are kept up to date and readily available;
- d) hazard and risk areas are to be clearly marked, based on the conducted risk assessments;
- e) workers are trained in all operations with corresponding records; and
- f) the requirements of 5.4 and 5.5 shall be applied.

5.2.2 Job knowledge

The person responsible for the management of the store or the warehouse shall ensure that all personnel concerned with the handling of gas cylinders are fully aware of

- a) the means of identifying the properties of the contents of the various gas cylinders held in the store by reference to the relevant safety data sheets (SDS), and

b) appropriate safety regulations and procedures.

5.2.3 Training

5.2.3.1 The person responsible for the management of the store or the warehouse where gas cylinders are kept shall provide training to the persons employed on the premises on

- a) the nature of the work and safe methods of operation,
- b) the properties and hazards associated with the cylinders handled,
- c) the location of first-aid equipment, and first-aid measures to be taken,
- d) the correct use of personal protective equipment, its care and maintenance,
- e) the location of the up to date emergency contacts and telephone numbers, and
- f) the actions to be taken in various emergencies, including gas escape, fire and explosions.

5.2.3.2 Particular attention shall be given to the training on the best methods of managing gas leakage and the steps to be taken to notify the supplier of any faulty cylinder.

5.2.3.3 Simulated emergency exercises shall be part of the training programme (see SANS 10263-0).

5.2.4 Hygiene and personal safety

5.2.4.1 All persons whose work involves the handling of gas cylinders shall

- a) not introduce, keep, prepare or consume any food or drink, or use tobacco or drugs in any area where cylinders are kept or handled,
- b) after handling gas cylinders, always wash their hands before eating, drinking, smoking or using the toilet, and after work,
- c) immediately attend to personal injuries caused during the handling of gas cylinders, and
- d) be forbidden to handle gas cylinders, or enter any gas warehouse facility whilst under the influence of any intoxicating substance.

5.2.4.2 Suitable signs shall be prominently displayed in the work area in accordance with SANS 1186-1 (see also 5.1.3).

5.3 Fire protection

5.3.1 The safety, fire protection and fire-fighting requirements shall apply.

5.3.2 The fire prevention officer shall be contacted by the owner of the business to ensure adequate fire prevention is installed on site and, where necessary, local authority approval shall be obtained. It is recommended that the fire prevention officer from the local fire department be consulted by the owner of the business to verify that the best possible practice is adopted.

5.3.3 All fire-fighting equipment is to be maintained in accordance with local regulations.

5.4 Housekeeping

5.4.1 Gas cylinders shall be used and maintained

5.4.2 The accumulation of materials especially those of a combustible nature in the vicinity of gas cylinders that are not in use shall be prohibited.

5.4.3 Provided it is safe, leaking or damaged cylinders shall be removed immediately to a safe area to await the advice of the supplier on the action to be taken. Flammable, toxic or corrosive contents of a leaking cylinder shall prompt evacuation of the area.

5.4.4 Clear unobstructed access to cylinders shall be available at all times for checking or retrieving.

5.4.5 Any cylinder considered unsuitable for use, for whatever reason, shall be removed to the "return to supplier" storage area (see 5.6).

5.5 Security

There shall be perimeter protection and access control to verify entry to, and exit from, the storage facilities. Contractor personnel shall be adequately screened and trained before admission to these facilities. See EIGA 907/05 for further guidance.

5.6 Cylinders for return to the supplier

5.6.1 A safe storage area for cylinders to be returned to the supplier shall be provided, and the segregation shall be identical to that provided for full cylinders. Cylinders stored in this area shall include damaged, leaking, wrongly supplied and empty cylinders. This area shall be established to accommodate such cylinders in accordance with 5.11.1.

5.6.2 Cylinders whose identification colouring is unclear, or labels are illegible or missing shall not be accepted at the time of delivery. Medical gas cylinders shall be colour identified

5.6.3 All faulty cylinders for return to the supplier shall be labeled to show the reason for their return in order to ensure that any irregularity can be resolved.

5.7 Misuse

Gas cylinders shall only be used for the intended design purpose. The warehouse personnel shall not remove any valve guards, shrouds and caps. Where valve outlet plugs, caps or heat-shrink seals are provided by the cylinder supplier, these shall be left in place.

5.8 Electrical circuits

Gas cylinders **shall not** be placed where they become part of an electrical circuit. When gas cylinders are used in conjunction with electric welding, they shall not be earthed (grounded) or used for earthing (grounding). These precautions prevent cylinders from becoming arc burned.

5.9 Temperature limits

5.9.1 Gas cylinders **shall not** under any circumstances be exposed to temperatures above 65 °C. If snow or ice accumulates on a cylinder, thaw at room temperature, or with water at a temperature not exceeding 40 °C.

5.9.2 Gas cylinders that have been exposed to fire shall not be transported if they still contain gas. The supplier shall be consulted and he shall arrange for the return of such cylinders. Special care shall be taken with aluminum and composite cylinders because elevated temperatures will alter their mechanical properties.

5.10 Handling of cylinders

5.10.1 Gas cylinders shall not be moved by horizontal rolling, dragging or sliding them on their bases.

5.10.2 Gas cylinders shall be manually handled by churning or using a suitable cylinder trolley, a forklift truck or a similar handling device with the cylinder securely held by the device. The device shall be employed, especially for gas cylinders that are large or heavy.

5.10.3 Accidental dropping or allowing cylinders to violently strike against each other shall be avoided.

5.10.4 Ropes and chains or slings shall not be used to lift cylinders by their valves, guards, shrouds or caps. Suitable cradles, platforms or pallets to hold the cylinders shall be used.

5.10.5 Smaller cylinders, typically medical oxygen cylinders, can be handled safely by their handles or shrouds as they are used by persons having serious breathing difficulties. They are designed to have a carrying handle that also serves as a valve protection device.

5.10.6 Personnel handling gas cylinders shall wear safety shoes, gloves and safety glasses. It is further recommended to wear metatarsal protection.

NOTE See annex A for further guidance to the safe handling of gas cylinders.

5.11 Storage

5.11.1 Storage configuration

5.11.1.1 In order to ensure best possible storage arrangements, the local emergency services shall be consulted, particularly when cylinders are to be kept in enclosed areas. In all instances a risk assessment shall be carried out.

5.11.1.2 The arrangement and quantity of gas cylinders in storage shall depend upon their classification, and the design of the storage area (segregated, separated or detached).

5.11.1.3 Cylinders shall be stored in a manner that avoids contact with incompatible materials.

5.11.1.4 Special care shall be taken to prevent physical damage to cylinders in storage.

5.11.1.5 Electrical installations shall be in accordance with international

Special attention shall be given to ensure that there is no excessive heat generated that could adversely affect the mechanical integrity of stored gas cylinders.

5.11.1.6 The storage arrangements shall take into account the risk of gases escaping from cylinders as a result of leakage or the malfunctioning of safety relief devices. The appropriate emergency response actions to be taken shall be clearly understood and practiced as training routines (see 5.2.3). BS EN 12101-2 and BS EN 12101-6 can also be consulted.

5.11.2 Storage requirements

5.11.2.1 All cylinders shall be stored in a vertical position, resting on their foot-rings or on specially formed bases unless they are mounted in a frame or pack where the cylinders are designed to be horizontal. Those cylinders with convex round ends are excluded from this requirement. Cylinders

with convex round ends and a water capacity above 10 L require special handling and storage arrangements.

5.11.2.2 The cylinders can be arranged in groups, each group containing up to four rows with gangways between the groups (see figure B.1(a) and figure B.1(b)).

5.11.2.3 Gangways shall be maintained between stored cylinders, walls and fences. When pallets or baskets are used, they shall be placed in single rows with gangways between the rows, with the outer row against a boundary wall (see figure B.2).

5.11.2.4 Cylinders shall be stored below 65 °C away from boilers, open flames, steam pipes and any other sources of heat or potential sources of ignition.

5.11.2.5 Cylinders shall be adequately segregated or separated (see 3.19.2, 3.19.3 and annexes B and C) so that they can be grouped together by the hazard class of the gas.

5.11.2.6 Separate storage areas shall be provided for full and empty cylinders applying the same safety principles.

5.11.2.7 Basement storage shall not be allowed subject to an approved rational design, as contemplated in SANS 10400.

5.11.2.8 Gas cylinders shall not be exposed to corrosive vapours.

5.11.2.9 Gas cylinders shall not be stored together with flammable substances in other types of containers (see 3.14).

5.11.2.10 Gas cylinders for underwater diving use shall be stored dry, in a horizontal position with the valve-outlet pointing downwards. However, removable bases (boots) are used in the diving industry and they allow the cylinder to be stored in a vertical position.

5.11.2.11 The stability of a cylinder is dependent on its shape. A tall cylinder with a smaller diameter tends to be unstable.

5.11.2.12 Cylinders shall be stored in pens or secured to ensure that they are not likely to be accidentally knocked over.

5.11.2.13 The number of freestanding cylinders shall be kept to a practical minimum working level and shall be arranged in the "honeycomb" formation (see figure B.3).

5.11.2.14 Since it is unavoidable that freestanding gas cylinders form part of "work in progress", cylinders shall be fixed to avoid the risk of being knocked over.

5.11.2.15 A hard standing (see 3.11) shall be provided for cylinder storage.

Annex A

(informative)

Safe handling of gas cylinders

This annex is based upon information produced by the BCGA (British Compressed Gas Association) under TIS (Technical Information Sheet) No.12: 2006.

HANDLE GAS CYLINDERS SAFELY

Muscular-skeletal disorders (MSDs), caused by the improper handling of gas cylinders, are one of the most common occupational illnesses.

Gas cylinders are generally heavy and are relatively unstable due to the base diameter to height ratio. Large cylinders can weigh over 100kg when full and, being tall and thin, they are easily toppled over. This Annexure has been produced to help users of large gas cylinders handle them in a safe manner.

1

Cylinders are heavy and should be handled with care. Cylinders should not be dropped or subjected to impact when being moved or used.

To handle cylinders safely you will need specific training in safe handling techniques. Speak to your employer or gas supplier for further information on training that may be available.



2

Assess the risk before lifting or moving the cylinder

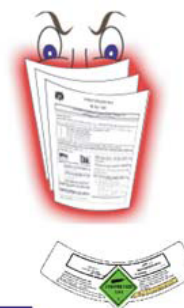
The Occupational Health & Safety Act (Act No: 85 of 1993 amended by Act No: 181 of 1993 and by the Labour Relations Act 1995) was promulgated to ensure health and safety in the workplace and is complemented by the General Safety Regulations it contains see GSR 2(i). This Document identifies the specific precautions to take when moving cylinders in your workplace.

- Ensure that you know the weight of the cylinder being handled.
- Check how far and over what type of surface the cylinder is to be moved. You should clear away any obstructions and debris on the route. Ensure that you know where you want to put the cylinder before you start to move it.
- If the cylinder is to be moved for a distance greater than a few metres, consider using a suitable trolley or other means of transport.
- Wet or cold cylinders are even more difficult to handle as they affect your ability to hold the cylinder securely.
- **BE aware of your limitations.** Ask yourself if you have the ability and technique to safely move the cylinder safely – if not, **SEEK HELP**.

Before handling or using gas cylinders you must understand the properties and hazards of the gas.

Check the cylinder label to ensure you have the correct gas.

The properties and hazards associated with the gas are given in the safety data sheet so take time out to read it. If in doubt ask the supplier for advice.



3

Always use appropriate protective equipment, see the safety data sheet. Eyes, hands and feet should be protected when handling or using cylinders. Many injuries to the foot affect the metatarsal (instep) bone. Footwear with metatarsal protection is recommended.



4

Do not move the cylinder with the valve open. When the cylinder is empty or you have finished with it, please return it to the supplier. The valve must be closed before transporting.



CLOSE VALVE

5

If cylinders are leaning over in their pallet or storage bay, do not attempt to straighten them by yourself. Get help and make sure that you know what everyone is to do to avoid trapping each other's fingers or being hit by a falling cylinder.

Always make sure that cylinder restraints are securely fastened after moving cylinders.



6

Avoid injury by using correct lifting method when raising a large cylinder from the horizontal position

Foot position: hip width apart with one slightly in front of the other, astride the valve end of the cylinder.

Bend the knees to lower your body. This will enable your thigh muscles to do most of the lifting.

Ensure that the valve guard is secure then take a firm grip using both hands. Only lift using the guard if it has been designed for this purpose, otherwise grip the cylinder neck.

Keep your back straight throughout its length. This does not mean it has to be vertical. Doing this will help to prevent a slipped disc. Pull your chin in so that your back is locked in a straight line and look in front rather than at the ground.

Lift decisively with a smooth non-jerking motion. It is done initially by straightening the legs then following through with the arms at the same time walking forward until the cylinder is upright.



7

When the cylinder is upright do not leave it free standing, but move it to a safe storage area.

The "churning" method requires the use of both hands. One supports the cylinder whilst the other rotates the cylinder (away from the body). It requires the cylinder to be tilted slightly (again away from the body). The method takes some practice and should only be attempted on a firm, even surface.



8

NEVER ATTEMPT TO STOP A FALLING CYLINDER - GET OUT OF THE WAY

Thank you for reading and following this guidance, it will help to ensure your safety.



Annex B
(normative)
Storage configuration

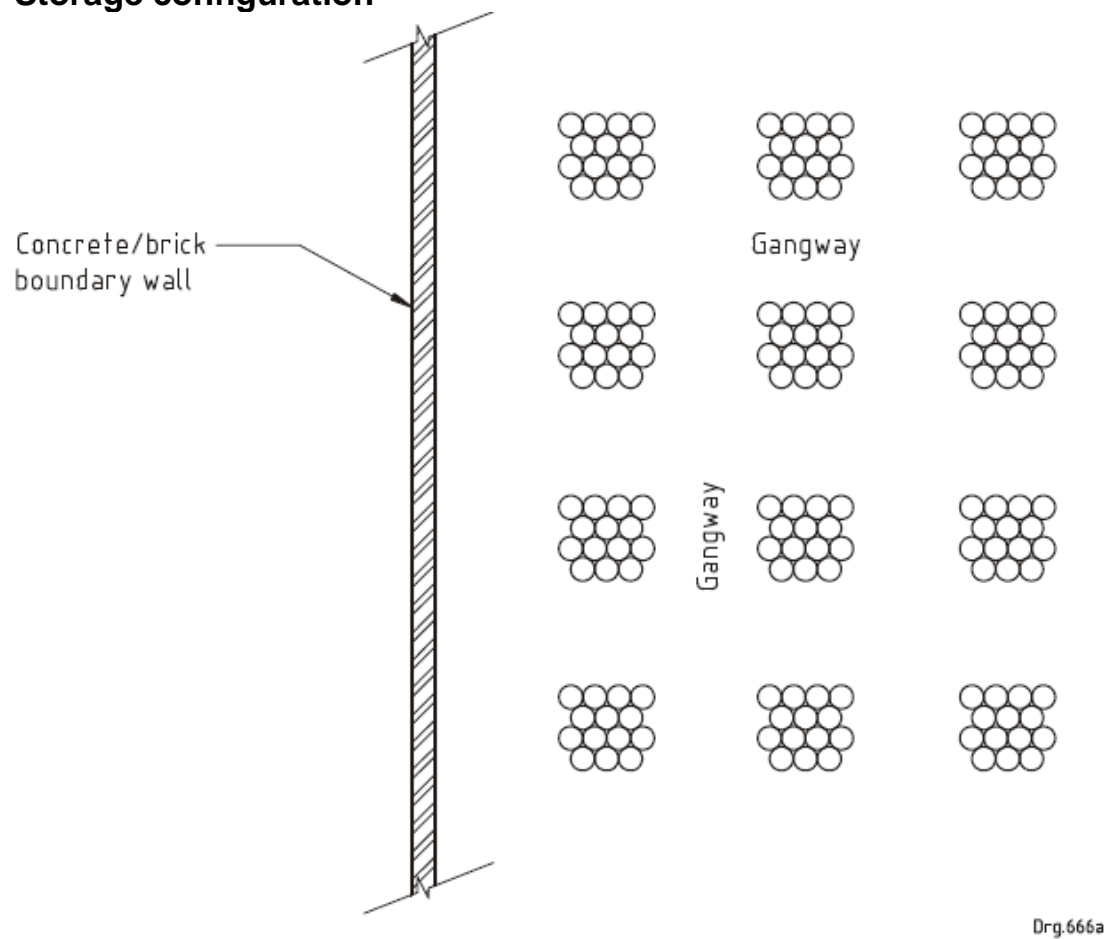


Figure B.1(a) — Gangways between groups of cylinders in the storage area

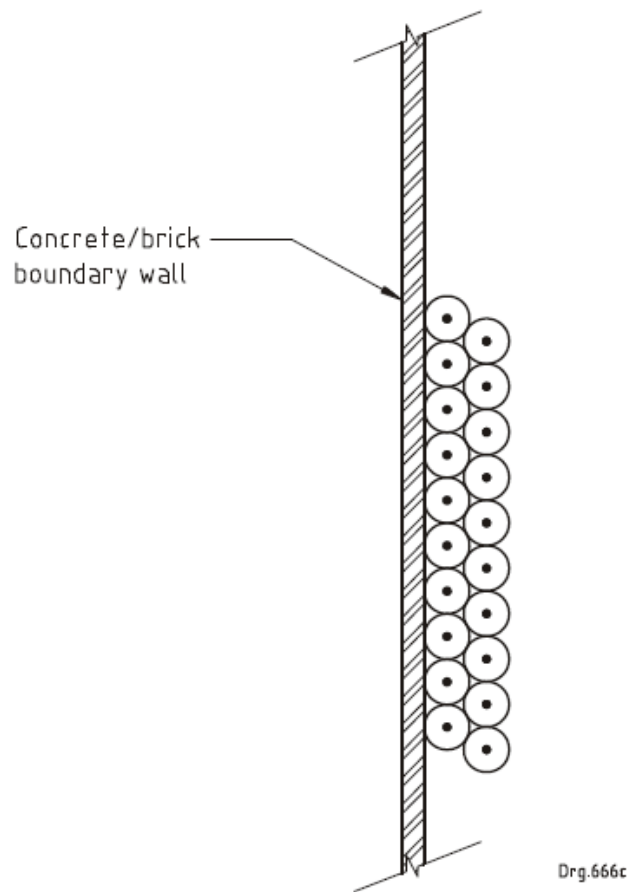


Figure B.1(b) — Cylinders against concrete or brick wall in the storage area

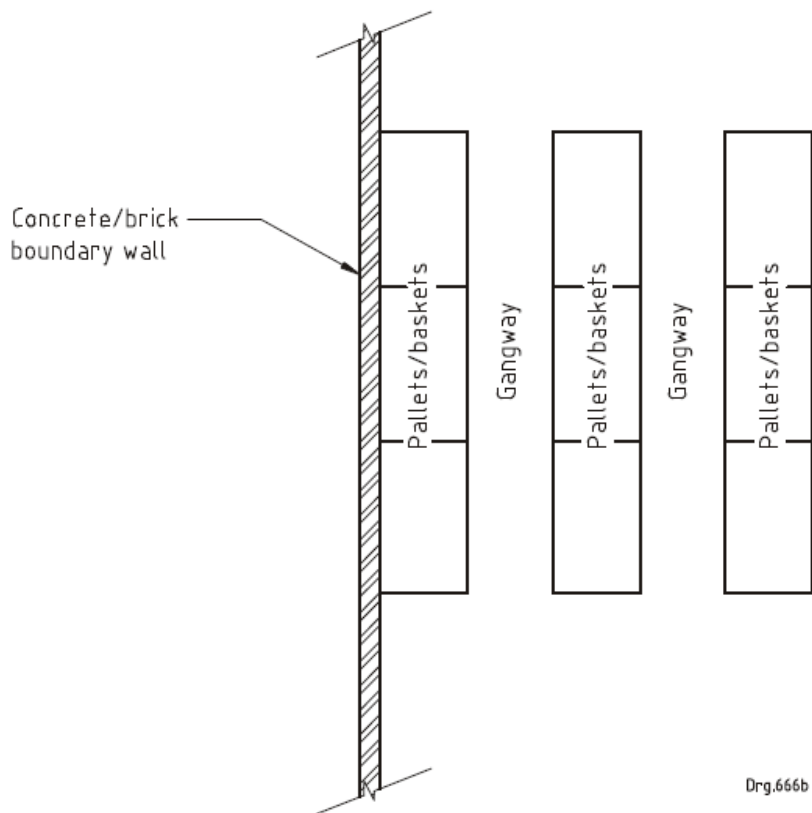


Figure B.2 — Pallets or baskets arrangement in the storage area

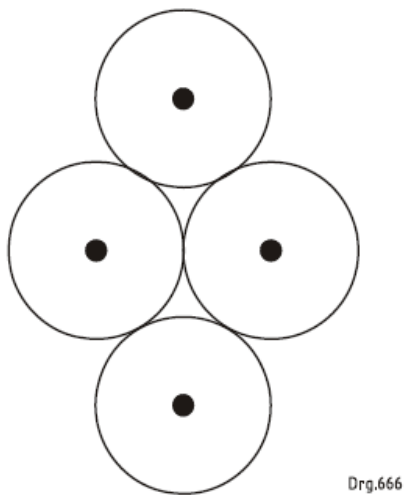


Figure B.3 — Honeycomb arrangement of cylinders in use

Annex C

(normative)

General principles of cylinder storage

C.1 General

C.1.1 Separation distances (see table C.1) shall be applied between gas cylinders containing flammable gases of division 2.1 and electrical installations that are not explosion proof. These separation distances can also be used between gas cylinders with flammable or oxidizing gases.

C.1.2 Each cylinder hazard type has a minimum recommended separation distance in accordance with table C.1. It should be noted that cylinder storage facilities are subject to the approval of the Local Fire Department.

C.1.3 Open air storage may have a roof, but typically there are no side walls.

C.1.4 Indoor storage includes walls as well as a roof and special care shall be taken to ensure high and low level ventilation and that the appropriate personnel protection equipment is available.

C.1.5 No separation is required for gases that are inert. However, it should be remembered that access to cylinders will be required and suitable walkway provision should always be provided. The separation distances can be reduced without limit if a barrier, such as a wall having a fire-resistance rating of at least 30 min and that is 1,8 m high is in place. There shall always be separate storage areas for full and empty cylinders. Because of the unknown residual product in empty cylinders, the same safety distances are required as if full.

C.1.6 All segregated areas for Class 2 gases (see 4.2) shall have signs that provide details of the product by name, and whether filled or empty as prescribed in 5.1.1.1 and 5.1.1.2.

C.1.7 Cylinder contents shall also be identifiable by the colour(s) that they are painted and the labelling

C.1.8 Where toxic/corrosive cylinders are stored as an adjacent group, no separation is required within the same product type, as there would be no reaction from leakage or spillage.

C.1.9 When storing cylinders near another hazard, special legislation concerning additional protective measures beyond those given in table C.1 shall be verified.

C.2 Recommended minimum separation distances.

C.2.1 The minimum separation distances between gas cylinders of different types and between gas cylinders and other features are given in table C.1 and table C.2 respectively.

Table C.1 — Minimum separation distances between gas cylinders of different types

1	2	3	4	5	6
Type of exposure (see C.1.3)	Minimum separation distance between gas cylinders of different types m				
	Inert gas including CO ₂	Oxidants	Flammable, compressed and dissolved gas, e.g. hydrogen and acetylene	Liquefied flammable gas	Toxic gas
Inert gas including CO ₂	0	0	0	0	0
Oxidants	0	0	1	1	0
Flammable, compressed and dissolved gas, e.g. hydrogen and acetylene	0	1	0	0	1
Liquefied flammable gas	0	1	0	0	3
Toxic gas	0	0	1	1	0

Table C.2 — Minimum separation distances between gas cylinders and other features

1	2	3	4	5
Feature (see C.2.4)	Minimum separation distance between gas cylinders and other features (see C.2.3) m			
	Inert gas including CO ₂	Oxidants	Flammable, Liquefied, compressed and dissolved gas, e.g. hydrogen and acetylene	Toxic gas (see C.2.3)
Site boundaries (see C.2.4)	1	1	3	3
Building openings	1	1	3	3
Smoking, naked flames sources of ignition and heat sources	1	1	3	3
Unprotected electrical equipment	0	0	3 (see C.2.5)	1
Air compressors and ventilator intakes (see C.2.6)	3	3	3 (see C.2.7)	3
Combustible materials, for example paper, wood, etc	0	3	3	3

C.2.2 In some cases physical partitions or barriers may be used to reduce the required separation distances. A suitably constructed firewall may eliminate the need for separation distances.

C.2.3 Where flammable toxic gases are concerned, the greater distance applies (see column 4 of table C.1 and table C.2).

C.2.4 A separation distance of 8 m should be applied where the site boundary forms the boundary with vulnerable populations.

C.2.5 A documented risk will identify if there is a need for protected electrical equipment or may justify the reduction or removal of a separation distance for unprotected electrical equipment.

C.2.6 The storage area shall not be directly below an air intake.

C.2.7 The separation distance is generally 3 m, but special consideration shall be given to the density of gas, for example if the gas is lighter than air, the windows, the air intakes and the openings should be above the storage area.